Atmospheric and Spectroscopic Research in the Far Infrared

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Final Report

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Submitted by

Kwangjai Park, PI

University of Oregon
Eugene OR 97403

INTRODUCTION

The University of Oregon (UO) was a participant in a number of far infrared spectroscopic projects over the past three decades. These include Sub-millimeter Infrared Balloon Experiment (SIBEX, references 1-3), the Balloon Intercomparison Campaign, (BIC, references 4-6), and the Infrared Balloon Experiment (IBEX). In addition to these field studies, the UO program contained a detector research component and a laboratory spectroscopy element. Through a productive collaboration with Dr. Carli's group in Italy, with Prof. Ade's group in England and with Dr. Chance of Harvard-Smithsonian, we have made substantial contributions to the development of far infrared spectroscopy as a mature measurement technology for the atmospheric science. This report summarizes the activities during the latest grant period, covering the span from February 22, 1998 to February 21, 2002.

LABORATORY SPECTROSCOPY

One of the major areas of our research program has been the spectroscopic measurements of molecular parameters. This part of our program has been conducted in close collaboration with Smithsonian Astrophysical Observatory (SAO) and National Institute of Standards and Technology (NIST). The references 7 through 17 list those line parameter measurements made by us during the previous and the current grant periods. These pressure broadening studies have provided the kind of improvements needed in the database for retrieving atmospheric profiles from far infrared limb sensing data.

One example of this linkage between the pressure broadening studies and the improvements in data retrieval is described in a paper on HBr (reference 13). The retrieval of the concentration profile of this important species from the IBEX data was facilitated by a number of performance improvement factors, not the least of which was the database improvements.

During the current grant period, our spectroscopic research has focused on finishing up the list of molecular species important to the atmospheric work. Our papers on H_2O 88, O_3 114 (reference

16) and OH 118 (reference 17) have been published, see below. In addition, we measured line parameters for H_2O_2 112, and HF 163. Analyses of our measured results for these species show discrepancies. We have not been able to resolve these discrepancies. Further studies are needed.

Two papers appeared during this reporting period:

K. V. Chance, K. Park, and K. M. Evenson, "Pressure Broadening of Far Infrared Rotational Transitions: 88.65 CM^{-1} H_2O and 114.47 CM^{-1} O_3," *J. Quant. Spectrosc. & Rad. Transfer* **59**, 687, 1998.

K. Park, L. R. Zink, K. V. Chance, K. M. Evenson, and I. G. Nolt, "Pressure Broadening of the 118.455 cm^{-1} Rotational Lines of OH by N_2, O_2, H_2, and He," *J. Quant. Spectrosc. & Rad. Transfer* **61**, 715, 1999.

IBEX DATABASE

We designed and implemented a preliminary version of worldwide web site for the IBEX database, using a prototype pc server running a LINUX operating system. We successfully installed the data atlas (reference 14) on this test-bed. Even as we were developing an ftp protocol, our system was badly compromised by a series of hacker attacks in April and May of 2000. We decommissioned this server in May 2000. Consultations with the collaboration members continue.

DETECTOR RESEARCH

Another area of focus in our program has been the far infrared detector research. Our collaboration with Professor Peter Ade's group at the Queen Mary & Westfield College has been extremely productive. During IBEX94, a dramatic improvement in the performance of the flight detector system was evident. Our goal was to adapt the new sensor technology to the laboratory detector at NIST TuFIR spectrometer, including a cold grating filter system. All components of this new detector system have been designed, manufactured, and delivered to NIST. A

preliminary study leads us to believe that this laboratory detector system would be an order of magnitude better than the existing technology.

The success of the spectroscopy for pressure broadening measurements at NIST (references 7–17) was due in part to detectors developed at UO.

OTHER ACTIVITIES

We have participated in the research dealing with remote sensing of cirrus cloud. We continued our involvement with this project, following the initial participation during the previous grant period [Nolt, et al, "Far Infrared Remote Sensing of Cirrus Cloud Parameters," *Proc. European Symp. On Aerospce Remote Sensing*, September 1997.] Mr. Predko, our Instrumentation Technician, was involved with the FIRSC instrument, as represented in the publication cited below.

Publication: M.D.Vanek, I.G. Nolt, J.A. Dempsey, P.A.R. Ade, F. Gannaway, C. Lee, K.F. Evans, J. Davis, and S. Predko, "FIRSC Instrument for Far Infrared Cloud Radiance Spectroscopy: Design and Performance," *Appl. Opt*, **40**, 2169-2176, 2001.

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